GROWING WINTER WHEAT ON THE GREAT PLAINS

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LIMITED RAINFALL is the controlling factor in crop production in the Great Plains. The average yields of a series of years can be foretold from the records of past years; but, because the rainfall is fluctuating in amount and uncertain in distribution, the yields of a single year can not be foretold with any certainty. The chances of success are, however, much better when the soil is wet to a considerable depth at seeding time than they are when the soil contains little or no available water at that time.

The relation between the amount of water in the soil at seeding time and the yield is much closer with winter wheat than with other crops. This crop should, therefore, be seeded on the best-prepared land and that in which the greatest amount of water is stored. Except in the southern section, the response of winter wheat to summer tillage is greater than that of any other crop. Summer-tilled land should be seeded to winter wheat wherever this crop can be grown. The growth of corn is one of the best preparations for winter wheat, especially north of Kansas.

With increase in the length of season and the time between harvest and seeding, there is an increase in the value of early preparation for winter wheat. In the northern section the crop can be replaced with spring wheat without serious loss. In the central section, winter wheat has a greater advantage over spring wheat and can not be replaced by the latter without serious loss. In the southern section, winter wheat is less certain and less productive than farther north and can not be replaced by spring wheat. It is, however, profitably raised under favorable conditions of soil, season, and preparation. In this section particularly it should be recognized that the chances of producing a crop are low when it is seeded on land that does not contain water enough in storage to wet the soil to a depth of 3 feet.

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FARMING CONDITIONS ON THE GREAT PLAINS.

THE SOILS of the Plains are generally rich. Fertilizers are never used. The broad level or rolling fields of the prairie lend themselves to an extensive agriculture in which large machinery can be used to advantage and a minimum of man labor be made to cover effectively a maximum acreage. Winter wheat is naturally adapted to such an agriculture.

The results of the experiments of the Department of Agriculture show that the most profitable and greatest returns per unit of labor are obtained by expending the labor on as large an acreage as can be efficiently covered rather than by attempting to obtain increased yields from a given acreage by concentrating a greater amount of labor upon it. The factor that determines and controls the agriculture of the region is the limited rainfall and its uncertain distribution. The uncertainty of the distribution of the rainfall rather than the total average quantity received is the factor that makes crop production hazardous. Over the greater portion of the Great Plains the average rainfall is sufficient to insure the production of crops, but the rainfall in any given year may be either above or below the average. When above the average the production of good crops is assured unless the distribution of the rainfall is very unfavorable. The crop may be destroyed by hail, but hailstorms are of local occurrence and do not affect general conditions. When the rainfall is much below normal it may not be sufficient to produce a crop. Under such conditions the greater the amount of water in storage in the soil

NOTE.—This bulletin is intended to answer the requests for information on the production of winter wheat on the Great Plains under dry-farming conditions that arise from the stimulus of a present and prospective price much higher than that under which the agriculture of the section has been developed and from the campaign for a large increase in the crop to meet the necessities of war conditions.

at seeding time the greater is the chance of making a crop. Water so stored is of advantage in supplementing the rainfall, but nowhere on the Great Plains can much more than a crop of straw be produced from the water in the soil alone.

From the results under known conditions in the past years the average results of a series of years in any section can be forecast with a reasonable degree of certainty, but nowhere on the Plains can the results of a single season be forecast. Knowing, though, that the greater the amount of water in the soil at seeding time the less dependent is the crop on the rain that falls while it is growing, it is possible to make at seeding time some forecast of the chances of success. Particularly is this true of winter wheat, which shows a closer relation between the yield and the water content of the soil at seeding time than any other crop. In a normal soil under dry-farming conditions winter wheat can use water from a depth of 6 or more feet. These soils are seldom wet to this depth when cropped every year and not usually beyond it when fallowed. The depth to which the soil is wet can usually be told easily by inspection, the break between wet and dry soil being very sharp. A good guide to practice is to sow a large acreage when the soil at seeding time is wet to as great a depth as 3 feet. This means that the conditions are favorable for germination and growth and that the chances for a crop are good, even though the winter and spring rainfall may be below the average. On the other hand, seeding in a dry soil means that the rainfall and other climatic conditions from that time forward must be better than the average if a crop is to be produced.

Only an exceptionally wet winter and spring could have produced a good winter-wheat crop on the Great Plains in 1917. There was no water in storage when it was seeded. The winter and spring being dry it had no opportunity to overcome this handicap.

VARIETIES OF WINTER WHEAT.

Two named varieties of winter wheat are of such superior merit in hardiness, yield, and quality that they are grown almost exclusively throughout the Great Plains. They are both of the same type and general appearance and belong to the hard red winter or Crimean group of wheats. The Turkey Red is the older of these varieties. Kharkof, a later importation of the same type, usually has been found slightly superior to the older variety in hardiness and yield and is now quite generally grown.

RATE OF SEEDING.

The relation between stand and yield is determined by so many varying conditions of season and the stand itself is affected by so many things besides the rate of seeding that no one best rate can be

established. Within a considerable range of rate the average yield is not greatly affected. If the ground is free from weeds a thick stand will generally be shorter and earlier and suffer sooner from drought than a thin stand. A thick stand, however, discourages the growth of weeds.

On a poor seed bed, in sections where winter injury is usually severe or when seeding is so late that there is time for but little fall growth, more seed should be sown than under other conditions. The usual range is from 30 to 60 pounds per acre. Good crops have been raised from seedings as light as 15 pounds and as heavy as 2 bushels per acre. Probably the greater bulk of the crop is seeded at the rate of 40 to 50 pounds per acre.

DATE OF SEEDING.

In the northern section of the Great Plains there is no danger of seeding winter wheat too early in the fall. The earliest sown wheat does not go beyond the rosette stage in the fall, and there is no growth during the winter. Wheat sown early enough to become well stooled in the fall survives the winter better and matures earlier than that sown later. In the northern and western portions of this section the best time is between August 15 and September 15, and in the southern portion of this section between September 1 and September 20.

In the central section wheat is seldom seeded earlier than September 15. Seeding may be continued until after October 15 but to sow after that date is considered undesirable. Wheat is sometimes sown late in this section to escape insect injury. Where there is danger of blowing during the winter and spring, early seeding is of advantage in making growth enough to protect the soil. But a heavy fall and winter growth makes an inefficient use of soil moisture and may contribute later to damage from drought.

In the southern section, the earliest date of seeding is the same as in the central, but the latest date may be much later. The usual time is from October 1 to October 15. Early seeding affords pasture and protects the soil from blowing, but late seeding tends to the conservation of water for use by the crop in the spring and avoids fall injury by insects, which is an important consideration in some sections.

ADAPTATION, RELATIVE VALUE, AND CULTURAL METHODS.

While certain cultural directions may be generalized either for the area as a whole or for considerable sections of it, such questions as the adaptation of winter wheat, its reliability and value in comparison with other crops, and its response to cultural methods may well be considered by States. With the wide range of conditions to be encountered within most of the States, even this method of considera-

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tion requires more generalization than is desirable in giving information that may be acted upon with assurance and profit.

MONTANA.

Only that portion of the State that lies east of the mountains is here considered. The western portion of this Plains area is well adapted to winter wheat. In the eastern portion of the area the winter survival of winter wheat becomes less and less until at the North Dakota line it can not be raised at all. As in any other section, winterkilling may be experienced in any part of the State. When this occurs, the loss is not so serious, as the land is prepared and can be reseeded with spring wheat. On the average, there is little difference in the yield of the two crops on land that raised a crop the preceding year. Land that has been summer fallowed should be seeded to winter wheat, as the relative response of winter wheat to fallow is much greater than that of spring wheat or of any other crop.

The lateness of harvest and the shortness of the season which makes it necessary to seed early leaves little or no choice as to time of plowing, nor is there much, if any, difference shown as a result of difference in depth of plowing. Indeed, both winterkilling and soil blowing are often guarded against by seeding in grain stubble without plowing. As this practice is apt to encourage the growth of weeds, it is to be advised only on clean land, and preferably on land that has either been summer fallowed or spring plowed for the preceding crop. In the Judith Basin the yield on summer-tilled land has not been enough greater than that on land producing a crop each year to justify the practice, but at Huntley, where the summer conditions are more severe, the yield has been nearly doubled. At both stations the second highest yield has been on disked corn ground. On account of its lower cost, this method of preparation has been the most profitable from the standpoint of the wheat alone. In addition to this, the corn in the Judith Basin has produced an average yield of about 2½ tons of fodder per acre and at Huntley of about 20 bushels of corn and 1¼ tons of stover per acre. Figured at normal prices of crops and labor, the most profitable combination of crops at any point on the Great Plains has been that of corn and winter wheat on disked corn ground at Huntley.

At the Judith Basin Experiment Station the average yield for the eight years, 1909 to 1916, inclusive, has been 24 bushels per acre. The only total failure was by the winterkilling of the crop of 1916. At Huntley the average yield for the 4-year period, 1913 to 1916, was 31.4 bushels, with no failures. These average yields are made up from about an equal division of the poorer and the better yielding

methods. The good farmer who is well equipped and able to handle his work in season should be able to equal them.

NORTH DAKOTA.

Winter wheat does not survive the winter and is not raised in North Dakota. The fall season is spent in preparation, chiefly plowing, for spring crops, of which wheat occupies the largest acreage.

SOUTH DAKOTA.

The only sections of the State in which winter wheat is now grown to any considerable extent are in the southeastern portion and in the Black Hills section. Winter wheat probably should be grown more extensively than it is. Special effort should be made to provide winter protection either by sowing in standing corn or in small-grain stubble that is clean and free from weeds. In the western portion of the State its winter survival is better. Here the chief troubles are likely to be a lack of moisture in the surface soil to germinate the seed and establish a stand in the fall and damage from drought during the growing season. At Belle Fourche the 8-year average yield of 23.1 bushels per acre from summer tillage has been nearly twice that from land producing a crop each year. Disked corn ground has not been under trial. At Ardmore the 4-year average yield from summer tillage was about the same as at Belle Fourche, but the comparative yields from other methods have been better. At both stations these very satisfactory average yields have been obtained from an almost equal division between years of near or complete failure and years of excessively high yields.

On the heavy clay soil of this section of the State the time of fall plowing is of much less importance than is the condition of the land when it is plowed. Land that is plowed dry is rough and lumpy and does not work into a good seed bed until it weathers down during the winter. On such land both the stand and the winter survival is likely to be poorer than on land plowed when in a friable condition.

NEBRASKA.

In western Nebraska there are two outstanding methods of excellence for the production of winter wheat. These are summer tillage and disked corn ground. At North Platte the average yield of winter wheat on summer-tilled land for 10 years was 30.6 bushels per acre, and that on early fall-plowed wheat stubble 15.3 bushels. During the five years it has been under trial the yield on disked corn ground has been fully equal to that on summer-tilled land. The 5-year average yield at the Scottsbluff station on summer-tilled land was 20.6 bushels; on disked corn ground, 15.4 bushels; on early fall-

plowed wheat stubble, 9.1 bushels, and on late fall-plowed wheat stubble, 5.4 bushels per acre. The use of corn instead of summer tillage as a preparation for winter wheat has the advantage of producing not only a profit from the corn crop but of adding to the feedstuff produced, thus making it possible to keep stock as well as to grow wheat.

WYOMING.

The results of the experiments at the Huntley, Mont., Belle Fourche, S. Dak., Ardmore, S. Dak., and Scottsbluff, Nebr., Field Stations are applicable in part to Wyoming. The results of the Archer, Wyo., Field Station apply to the higher altitudes in the southeastern portion of the State.

Winterkilling becomes increasingly worse with increase of altitude and with decrease of precipitation. At high altitudes a crop after surviving the winter may be seriously damaged by spring freezes. If the crop survives, winter wheat has a general advantage of yield over spring wheat, partly due in this section to its earliness, enabling it to avoid summer drought. Summer fallow has the advantage of providing some protection from drought, but on account of the bare smooth surface is more liable to winterkilling and spring blowing than other preparations. Both the winter survival and resistance to drought following corn or other cultivated crops are so good that these are among the best preparations for winter wheat. Perhaps the best crops are grown the first year after breaking prairie sod. Sufficient time should elapse between breaking and seeding to allow the storage of several inches of water in the soil. This is generally accomplished by breaking in the spring, letting the ground lie bare during the summer, and seeding in the fall.

Particularly in the higher altitudes at which wheat is grown, one of the most successful methods is that of seeding directly in stubble without preparation. The stubble should be clean and free from weeds, the ground not too dry, and preferably plowed in the spring before seeding the last crop.

COLORADO.

Winter wheat is one of the best small-grain crops for eastern Colorado. Particularly is this true if it can be sown on carefully prepared land, such as summer tilled, including new breaking of prairie sod, or corn ground. At the Akron Field Station the average yields for the seven years, 1910 to 1916, inclusive, were 23.1 bushels on summer-tilled land and 19.7 bushels on disked corn ground. Following small grains the average yields for the same years were between 13 and 14 bushels per acre, with little difference resulting from variation in time of plowing or other treatment.

KANSAS.

The experimental work of the United States Department of Agriculture in western Kansas has been conducted in cooperation with the State experiment station at the substations at Hays, Garden City, and Colby.

With the decreasing rainfall from east to west in western Kansas, there is a decreasing certainty as to the production of a crop. The northwestern portion of the State shows a better adaptation to winter wheat than the southwestern or Arkansas Valley section. Winter wheat is so much more successful than spring wheat that it is grown almost exclusively. Only in emergency is it replaced with spring wheat, and then with a much lower expectation of a profitable crop.

The early harvest and long season here gives a very marked advantage to earliness in fall plowing or listing. While corn ground has an advantage over late-prepared land, it does not have such an advantage over land prepared immediately after harvest. The latter is in turn exceeded in yield but not in profit per acre by land that is summer tilled. The beneficial effects of summer tillage may be realized in some cases and at the same time a crop of corn may be produced by leaving every other row of corn blank and maintaining clean cultivation. At Hays the average yields per acre for the 9-year period, 1907 to 1916, exclusive of 1912, when the crop was destroyed by hail, were as follows: Summer tilled, 22.7 bushels; listed after winter wheat, 19.2 bushels; early fall plowed after winter wheat, 17.6 bushels; disked corn ground, 15.4 bushels; and late fall plowed after winter wheat, 11 bushels. Where there is great danger from blowing, both blowing and winterkilling are sometimes successfully guarded against by seeding directly in stubble without preparation. Such crops are likely to be more weedy than cultivated land and to suffer more quickly from drought. But as a successful general crop in the western counties, to which this practice is confined, is dependent upon an unusually favorable rainfall during the growing season, this latter objection may not be as vital as might at first appear.

Kafir or other sorghum ground is very poor preparation for wheat in this section. This is contrary to the results farther north, where sorghum ground may be as productive as corn ground.

OKLAHOMA.

Owing to the short period during which the field stations at Woodward and Lawton have been in operation, few experimental data are to be cited from western Oklahoma. Of all the small grains, winter wheat is by far the best adapted to this region. In case of failure it can not be successfully replaced with spring wheat. In this area, the

winter pasturage furnished by winter wheat is an important consideration in determining the acreage it occupies. Pasturing is necessary in some seasons to prevent too great a growth.

Summer tillage is not practiced to any great extent, partly perhaps on account of the long season. Where the crop follows small grain, early preparation is essential to the best results. Several months elapse between harvest and seeding. If the ground is plowed or otherwise cultivated during this period, there is a chance for the storage of water which would otherwise be used by weeds.

Unless pasture is a prime consideration, seeding should be late. It is necessary that the plants start growth and become established before winter, but any growth in excess of this uses water during the fall, winter, and early spring that may be needed in drought protection during a later critical period. Corn, bean, and cowpea land is a much better preparation than any of the sorghums, including broom corn.

TEXAS.

Panhandle conditions are represented by the Dalhart and Amarillo Field Stations. The sandy soil on which the Dalhart station is located is not at all adapted to the growth of wheat or any other small grains except winter rye. A good crop of winter wheat may be produced occasionally, but no dependence is to be placed on it.

On the heavier soil represented by the Amarillo substation, the winter-wheat crop is more reliable. An 8-year average of yields at Amarillo varied from 7.1 to 10.6 bushels per acre according to tillage methods. In half the years the yields were fair and in half they were poor. The difference in yields resulting from different methods of preparation was not great in either the good or the poor years. The highest yield, 10.6 bushels, was from summer tillage, but this is less than a bushel more than the yield on early fall plowing of winter-wheat stubble. Small-grain stubble, no matter how treated, was more productive than corn ground.

Late seeding is advisable. This lengthens the period of water storage and reduces the amount of water used by the crop in the fall, winter, and early spring. Farther south, in the region locally known as the South Plains, wheat is more extensively grown than it is in the Panhandle. Presumably this is because it is more successful and more profitable, but no comparative data can be given.

In the territory represented by the Big Spring Field Station, winter wheat is grown to a limited extent. Success with it here is dependent on a season better than the average.

NEW MEXICO.

Winter wheat is the best adapted of any of the small grains except winter rye to eastern New Mexico. It is not adapted to sandy soils,

such as that on which the Tucumcari Field Station is located. Its growth is confined to the heavier soils of the level plains and the high altitudes of the mesas. Little advice based on local experimental evidence can be furnished. From all the evidence available it would appear that slightly the highest yields may be obtained from summer-tilled land, but that returns nearly as large, and by far the most profitable, will result from preparation that began as soon as possible after harvest. Winter wheat makes a good first crop on land that is broken long enough before seeding to be filled with water to a depth of 3 feet.

GENERAL CONSIDERATIONS.

From the standpoint of winter wheat production, the Great Plains region divides rather naturally into three sections, merging, of course, rather gradually into each other—the northern, the central, and the southern sections. The northern section includes the Plains portion of Montana and Wyoming, western South Dakota, and a portion of western Nebraska. In this section the average yield of winter wheat is little above that of spring wheat. When it fails to start growth or to survive the winter, its place may be taken by spring wheat without serious loss. The response of the two to cultural methods is generally about the same.

Harvest is late and seeding early. In the northern portion of this area and in the higher altitudes, harvest and seeding time are so near together that old wheat is generally in demand for early seeding. Under these conditions there is no chance to distinguish between early and late plowing or preparation. In the sections where winterkilling is the worst, it is necessary to resort to extreme measures of protection, such as seeding in standing cornstalks or in small-grain stubble without preparation. Corn or other cultivated ground is one of the best preparations in this section.

In the central section, winter wheat is primarily the most important grain crop. It can be replaced with spring wheat only at a decided loss in yield, quality, and certainty of crop. Here there is greater response to cultural conditions. This response being greater for winter wheat than for other grains, that crop should be seeded on the best-prepared land. The season being longer, there is more time between harvest and seeding and consequently a decidedly favorable response to earliness of preparation. Early fall plowing or listing may be exceeded in yield, but generally not in profit per acre by summer tillage. While corn or other cultivated ground is a good preparation in this section, it has not the unqualified superiority over other methods that it has farther north.

In the southern section the expectation of a high average yield is less than in either of the other sections, and at the same time the

response to cultural conditions is less. While there may be winterkilling in this section it is not of the great importance it is farther north. In case of winterkilling the crop can not be replaced with spring wheat with any degree of success.

Neither corn ground nor the sorghums, which are grown so extensively here, make a good preparation, although corn ground is much better than sorghum ground. Early preparation is important. Seeding should be late, unless pasture is a prime consideration.

The high price guaranteed for wheat and a laudable patriotic desire to contribute to the world's food supply will undoubtedly lead to the sowing of many fields under conditions from which only failure can reasonably be expected. Effort that results only in the waste of seed is to be discouraged.

In the southern section of the Plains, where the adaptation of wheat is naturally low and where the winter and spring precipitation is normally low, it should be clearly recognized that seeding on dry soil incurs a risk of failure scarcely justified by the chances of success. Precipitation during the winter and spring may be so abnormally heavy as to make a crop, but the chances are very much against it.

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